U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 32.

SILOS AND SILAGE.

CHARLES S. PLUMB, B. S.,
Professor of Animal Industry and Dairying in Purdue University and
Director of the Indiana Agricultural Experiment Station.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1895.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., July 27, 1895.

SIR: I have the honor to transmit herewith for publication as a Farmers' Bulletin an article on Silos and Silage by C. S. Plumb, professor of animal industry and dairying in Purdue University and director of the Indiana Experiment Station.

The extended use and increasing popularity of silage as a feeding stuff, and the widely scattered and somewhat fragmentary character of the literature on the subject, emphasize the need of a concise discussion of the best methods of constructing silos and of preparing and using silage. It was with a view to supplying this need that the services of a recognized authority on the subject of silage were secured in the preparation of this article.

Illustrations Nos. 1 to 4 of the Bulletin are taken (by permission) from publications of the Wisconsin Station; Nos. 8 to 10 from Silos, Ensilage, and Cattle Feeding, by F. A. Gulley; and Nos. 5 to 7 are furnished by the author.

Respectfully,

A. C. TRUE,
Director.

Hon. J. STERLING MORTON,
Secretary of Agriculture

CONTENTS.

LIST OF ILLUSTRATIONS.

SILOS AND SILAGE.[1]

HISTORICAL.

The silo originally was a pit or room, below or above ground, used for the storing of grain. In very early times in Egypt, Italy, Spain, and Mexico seed was stored in such rooms. In so called dry regions the grain was often covered with straw and the storehouse sealed up with masonry or other material. In damper climates the contents were best preserved when ventilation was permitted. This method was adopted to preserve the grain from insects and moisture, and also to hold it over from years of plenty to times of scarcity of food supply.

The preservation of green food in silos possibly commenced about one hundred years ago. In 1786 Symonds wrote of Italians preserving fresh leaves for cattle in casks and pits in the ground. In 1843 Johnston, an Englishman, published an article on preserving green clover, grass, or vetches in pits, basing his statements on observations made in Germany. Pits were dug 10 to 12 feet square and about as deep, the sides lined with wood, and a clay floor made. The green stuff was placed in the pit, and plenty of salt scattered over it from time to time. When the pit was full, the top was well salted and a close-fitting cover of boards was placed over it. Dirt to the depth of a foot or so was thrown on the cover to exclude air. In a few days, after the contents had fermented and settled, the cover was removed and more green fodder was thrown in and the cover again put on. In commenting on the contents of such a pit Johnston notes that the grass when thus fermented had the appearance of being boiled, had a sharp acid taste, and was greedily eaten by cattle.

In England, between 1860 and 1870, Samuel Jonas stored tares or rye, cut green and chaffed, and fed the fermented material on an extensive scale.

Adolph Reihlen, a sugar manufacturer of Stuttgardt, Germany, probably stored the first green maize in pits. He also preserved green beet leaves and beet pulp in silos with much success. He had lived a number of years in the United States, and on his return to Germany experimented with large dent corn, the seed of which he carried with him

[1] The word "silo" refers to a pit or room used for storing green forage. The contents of the silo are known as silage or ensilage. The process of handling and storing the silage may properly be termed ensiling.

from this country. As the crop did not always mature in that climate, the green crop was pitted after the manner of the beet refuse. This work was conducted between 1860 and 1870, and the results were published in the German and French papers of the time.

The use of the silo was strongly urged upon the people of France, and considerable attention was given to the subject. Many farmers built silos on the basis of Reihlen's experience. In 1877 A. Goffart, of France, wrote a book on "ensilage," which was translated into English and published in New York a year or two later.

The first to prepare silage in the United States were Manly Miles, of Michigan, who built two silos in 1875, and Francis Morris, of Maryland, who commenced experiments in this line in 1876. Several other silos were also built by people in the Eastern States within the next few years. In 1882, in a report on silage by the United States Department of Agriculture, statements were published from 91 persons who had silos. These were located as follows: Massachusetts 28, New York 21, Vermont 11, Connecticut and New Jersey 5 each, Maine 4, Wisconsin 3, New Hampshire, Maryland, Virginia, and Canada 2 each, and one each in Rhode Island, Kentucky, Tennessee, North Carolina, Iowa, and Nebraska. No doubt numerous others were in use at that time.

At the present time the silo is found on many thousands of farms in the United States, especially in dairy regions, and it may be considered a well-established fixture in American farm economy where stock feeding is practiced.

CONSTRUCTION AND COST OF SILOS.

The first silos made in the United States were of stone or brick. The walls were thick, very strong, and were covered with a smooth coat of cement on the inside. These were very expensive; consequently wooden silos were tried, and it was found that very satisfactory results could be secured with these at a much less cost than with stone or brick silos.

In constructing a silo it will be well to keep in mind the following points:

Make the silo deep, for the greater the depth the greater will be the pressure on that below, thus forcing out air from the fodder and insuring better silage. Shallow silos as a rule give less satisfactory results than deep ones, as there are larger air spaces in the silage, owing to lack of pressure. Wherever practicable the silo should have a depth of not less than 24 feet, while more satisfactory results may be expected if it is 10 feet deeper. If necessary the silo may extend 4 or 5 feet below the surface in order to obtain such a depth. It must, however, be borne in mind that good silos may be built 20 feet and even less in depth.

Make the silo walls smooth.—After the silage is placed in the pit, it should settle evenly and easily. If the walls are perfectly vertical and smooth, the conditions for settling will be favorable. Where stone is

used, a coat of water-lime cement must be used to make a good surface. As silage contains acid, this smooth surface will gradually become eaten and rough, so that from year to year, as seems necessary, a light wash of cement should be brushed over the wall to make it smooth. Where wood is used, the lining boards should be dressed on one side. The wall on the inside should be perfectly plumb and smooth from the top of the silo to the foundation wall, from the top of which there may be a slight bevel to the floor. There should be no blocks or rods against the walls at any place to prevent the uniform settling of the contents. In any form of wooden silo, excepting the round, it is desirable that the inside lining boards be nailed on vertically. The silage will then slip down more easily than where it rubs against the edges of the boards nailed on horizontally.

Have as few corners as possible.—Upon the thoroughness of the packing usually depends the character of the preservation. Most of the waste which occurs where silage has been well put in occurs at the surface, against the doors, at the sides, and in the corners. The corners are difficult to pack well; hence a loss is often found there. One of the advantages of a round silo is the absence of corners. In the square or rectangular form the corners may be filled in with triangular pieces or boarded over for about 12 inches. If the foundation wall is only 2 or 3 feet high, it will be desirable to bevel from its upper inside edge to the floor, thus reducing the floor corners. If the door boards fit smooth and flush with the inside of the wall, there should be but little decay of silage there.

Use gas tar on wooden silos, for when applied hot it is considered the best known preservative of wood available for common use. Even put on cold, if not too thick for rapid painting, it is a superior preservative. Tar may also be thinned with gasoline without the use of heat. As gasoline rapidly evaporates into a gas which is very inflammable, much care should be used not to expose it to fire. The edges, ends, and sides of the inside linings can be tarred to advantage. As the moisture coming from the silo is acid and tends to promote the decaying of wood, the use of a preservative is especially desirable. Consequently, the more completely the timber used is tarred the better fitted it will be to resist decay.

FORM OF SILO.

The two most desirable forms are round and square. The round silo contains the least amount of waste space, and presents the greater strength, for an equal pressure is distributed against the walls at every point from the center, so that it can not press out or bulge. Taking equal capacity into account, the round silo requires less lumber than the other forms. The square silo may be built to advantage in the corner or bay of a barn, where it would not be advisable to place a round one. If to be built to stand by itself, with walls independent of a barn, the square form is preferable to the rectangular. The walls are

stronger. For equal capacity there is less waste wall space in the square. When of the same depth and including equal amounts of side exposure, the square form will hold very much more silage than the rectangular.

Inside linings of numerous kinds have been tried. Where stone or brick is used, the final dressing should be of Portland cement with a very smooth finish. The contents of such a silo may be expected to keep well. King considers that such a cement wall will last ten years, and where a yearly washing of cement is applied it will last twenty or thirty years.

Lathed and plastered silos have not been a general success. In those cases known to the writer the plaster has suffered from cracking or has been injured by the fork. The plaster also softens from the acid of the silage. Moisture finally makes a passage through the plaster and injures the woodwork, which begins to decay.

Inside linings of sheet iron or roofing tin are not entirely satisfactory. The metal rusts, even if coated with paint or coal tar, since it is difficult to prevent abrasions of the coat during the season of use. Further, the action of the acid injures the efficiency of the paint for the purpose intended. Roofing tins usually are coated with lead, from which deleterious effects may be expected, as the lead compounds are poisonous. At the Wisconsin Station two silos were lined with metal—one with tin and the other with sheet iron—and these were discarded after a brief trial as unsatisfactory.

The best inside lining, all things considered, would seem to be two layers of boards with tarred paper between. The first layer should be placed horizontally against the studs. Over this should be placed the paper. If the silo is square or rectangular, the next layer of boards should be placed vertically on close edges. If the silo is round, the second layer should go on horizontally, with the strips nailed so as to break joints with the first layer. In the round form boards one-half inch thick by 4 to 6 inches wide should be used.

MISCELLANEOUS SUGGESTIONS.

The floor may be made of stiff clay with some grout work in it to keep rats from burrowing up into the silage. If clay is not available, 3 or 4 inches of grout should be laid. The main object is to make a firm, smooth, close, rat-proof floor. A layer of concrete is highly recommended.

The walls of wooden silos remain sound longest when they are well ventilated. Where they are carefully boxed up, moisture accumulates within and decay occurs. Auger holes bored between studs at the bottom give sufficient ventilation if there are openings at the top of the wall. All these holes or openings should be covered with wire screen to keep out rats and mice. The studs should be strong so as to guarantee against springing under the great pressure to which they are subjected.

The feeding door should be about $2\frac{1}{2}$ to 3 feet wide, and extend in sections from the sill to within 3 or 4 feet of the top, each section being about 5 feet long. Portions of the wall 2 to 3 feet wide should be left between the sections of the door at sufficient intervals to make the wall perfectly strong. Some persons prefer iron rods for this purpose, and then have a continuous line of doors from top to bottom. Boards as long as the door is wide must be placed horizontally in the frame, edge to edge and flush with the inside of the silo, resting against cleats nailed on the inside of the casing. These boards may be put in place as the silo is filled. The studs on each side of the door should be reenforced to give sufficient strength to the silo wall at this point.

The foundation wall should extend below frost line, and be 18 inches thick. The situation ought not to admit of water draining into the silo at any time.

Weatherboarding is not essential on the outside of the silo to preserve the contents. The writer has seen one large round silo with no weatherboarding whatever. The cost of the dressing outside of the studs is thus saved, but a silo so left is not an attractive-looking farm building. It is important to note, also, that in the colder parts of the country, where severe freezing occurs, a good covering outside of the studs reduces the freezing. Warm silage is more palatable than that permeated with frost.

Square or rectangular silos should be tied across the top by joists or cables to opposite studs, to keep the walls from spreading. In a silo 15 feet long two ties would be ample, and one might do.

Partitions are objectionable unless in shallow silos. They reduce storage space, are inconvenient, and along the walls and in the corners caused by them usually occurs more or less waste silage.

The sills, well tarred, should rest on a good foundation and be bedded in cement or mortar. It is important to have sills well above the soil on the outside, and at least a foot above the floor on the inside. In the square or rectangular forms, they should be anchored to the wall so as not to spread. This is usually accomplished by placing strong bolts in the wall when laying it, arranged to extend up through the sill (see fig. 6, p. 14). This is unnecessary with round silos.

A roof is required only on silos built out of doors, independent of buildings. The cost of the roof is largely a matter of taste. Rain and snow, however, should be excluded from the silo, and if a close roof is placed on the building, then a cupola or window should be built with a view of giving good ventilation. It is also essential to have a dormer window or door in the roof through which to fill the silo. This should be wide enough to admit the end of the carrier and allow a person to pass in by the side of the latter.

The capacity of the silo should depend on the needs of the farmer. A cubic foot of silage under average conditions will weigh 35 to 40 pounds. Ordinarily, this amount is enough, with other food, for a day's

feeding for one cow. If silage is fed one cow 200 days, she will consume 8,000 pounds or 4 tons. Ten cows will consequently require 40 tons. Allowing for some waste and emergency conditions, 50 tons would be a liberal estimate for these animals.

For a round silo 30 feet deep, King gives the following dimensions for herds of different sizes, estimating 5 square feet of surface silage for 1 cow:

	Feet.
30 cows, 150 square feet, inside diameter silo	14
40 cows, 200 square feet, inside diameter silo	16
50 cows, 250 square feet, inside diameter silo	18
60 cows, 300 square feet, inside diameter silo	19½
70 cows, 350 square feet, inside diameter silo	21¼
80 cows, 400 square feet, inside diameter silo	22½
90 cows, 450 square feet, inside diameter silo	24
100 cows, 500 square feet, inside diameter silo	25¼

ROUND SILO.

The accompanying illustrations, reproduced from publications of the the Wisconsin Experiment Station, give an idea of the appearance and

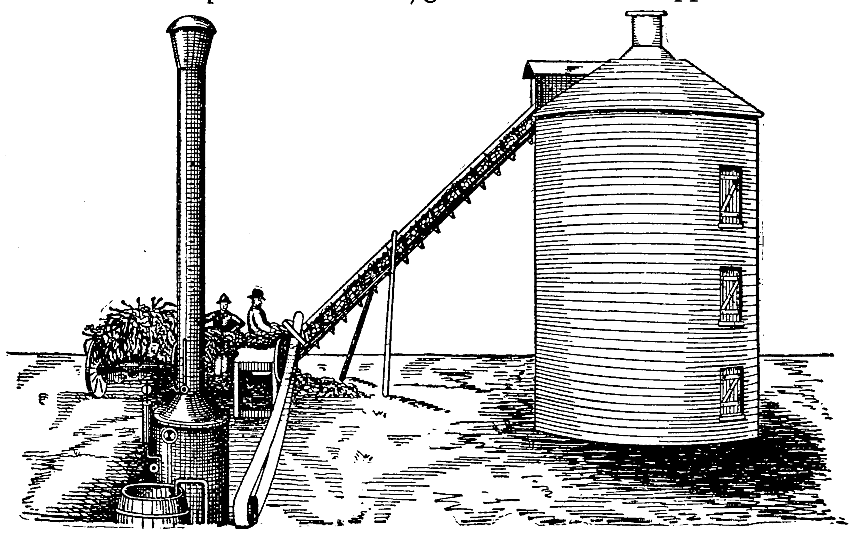

FIG. 1.—Small round silo at Wisconsin Agricultural Experiment Station. Diameter, 16 feet; depth, 27 feet; capacity, 80 to 90 tons.

method of filling a round silo (fig. 1) and explain in a measure the process of constructing a silo of this kind. Fig. 2 shows a method of laying

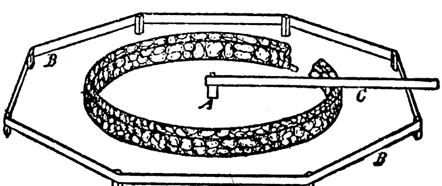

FIG. 2.—Method of laying and leveling the foundation of a round silo.

and leveling the foundation. *A* is a center post with top level with top of proposed wall; *B B* are straightedge boards nailed to stakes driven in

the ground; *C* is a piece of straightedge timber fixed to turn on a pin at *A; B B* are all nailed level with top of post *A*. Fig. 3 shows the construction. The sills are 2 by 4 inches in 2-foot sections with the ends cut on the slant of a radius of the silo circle; these should be sawed out with much care. After being bedded in mortar they may be toe-nailed together. The plates are the same, spiked to top of studs, which are 2 by 4 inches, 1 foot apart. Short lengths of studs may be used, lapped to get the depth; sixteens and fourteens will give a silo 30 feet deep. Linings are made from fencing sawed to give one-half inch in thickness; outside sheathing the same. Siding for silos under 28 feet, outside diameter, common siding, rabbeted; for diameter over 28 feet outside, common drop siding or ship lap may be used.

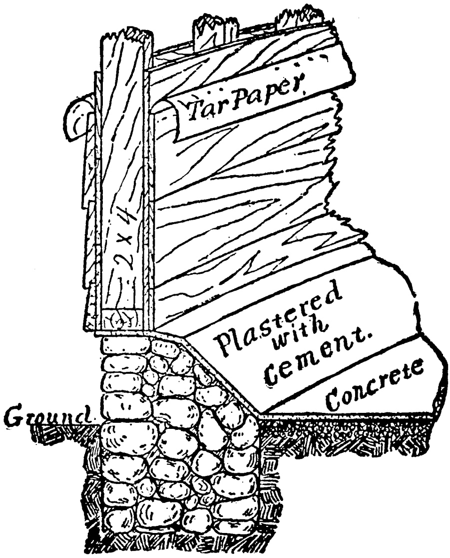

FIG. 3.—Construction of a round silo.

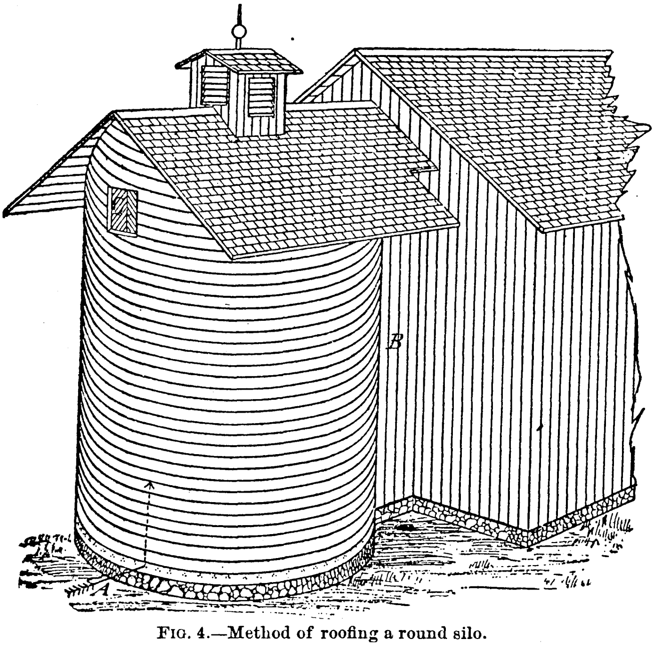

FIG. 4.—Method of roofing a round silo.

In fig. 4 is seen a method of roofing a round silo, and manner of connecting it with a barn. *A* shows where air is admitted between

studding to ventilate behind the lining; *B* is the feeding chute; the filling window is just below the roof, and the cupola serves as a ventilator.

SQUARE OR RECTANGULAR SILO.

In building a square or rectangular silo, the sills should be of 2 by 10 inch plank, in two layers, halved and spiked at the corners (fig. 5). These sills must be held in place by bolts well anchored in the founda-

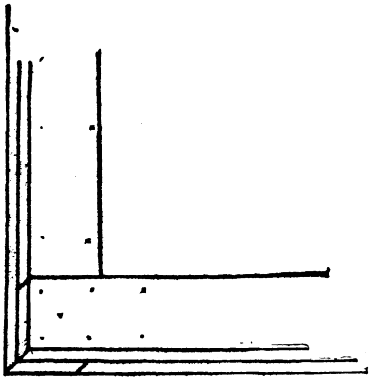

FIG. 5.—Fastening of sills at the corners.

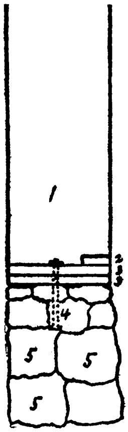

FIG. 6.—Fastening of studs to sills.

tion (fig. 6). The stud, 1, should be blocked against a strip, 2, nailed to the sill and a bolt, 4, driven through the sill, 3 3, into the wall, 5 5. The 2 by 10 inch studs are toe-nailed to the sills, 18 inches apart from center to center. If the silo is to be more than 20 feet deep, then 2 by 12 inch sills and studs should be used instead of 2 by 10's, on account of the increased side pressure from within. The base of each stud should be cut on the outside to block against a 2 by 4 inch piece spiked along the outer line of the sill, to prevent spreading. The studs at the top are fastened with a strong plate to which they are spiked. On the inside of the silo, beginning at the foundation, No. 1 fencing stuff is first nailed close. Over this is placed the layer of tarred paper, and following this the last inside lining is placed on, vertically (fig. 7).

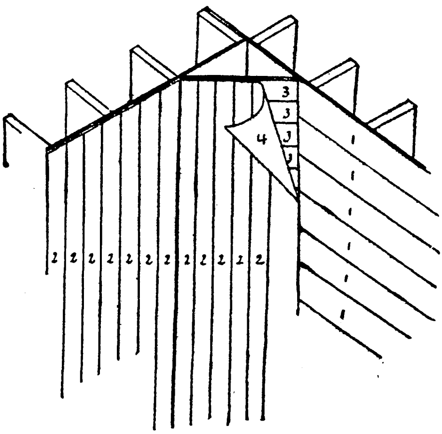

FIG. 7.—Corner of square or rectangular silo. 1, first inside lining; 2, second inside lining; 3, lining across corner; 4, tarred paper between linings.

It is important to note that the inside linings of either the round or square silo should be free from holes and black knots, consist of first-class well-seasoned stuff, and be of uniform width of board, so as to match properly in constructing. Gas tar should be liberally used on both of these linings.

The exterior of the silo may be covered to suit the builder, though it will be desirable to first put on a layer of common boarding, then building paper, and lastly clapboards or weatherboarding.

SILO WITH HORIZONTAL GIRTS.

The following illustration, taken from Gulley's work on Silos, Ensilage, and Cattle Feeding, shows a double silo, with a framing consisting of horizontal girts, which has certain obvious advantages and has been tried with good results.

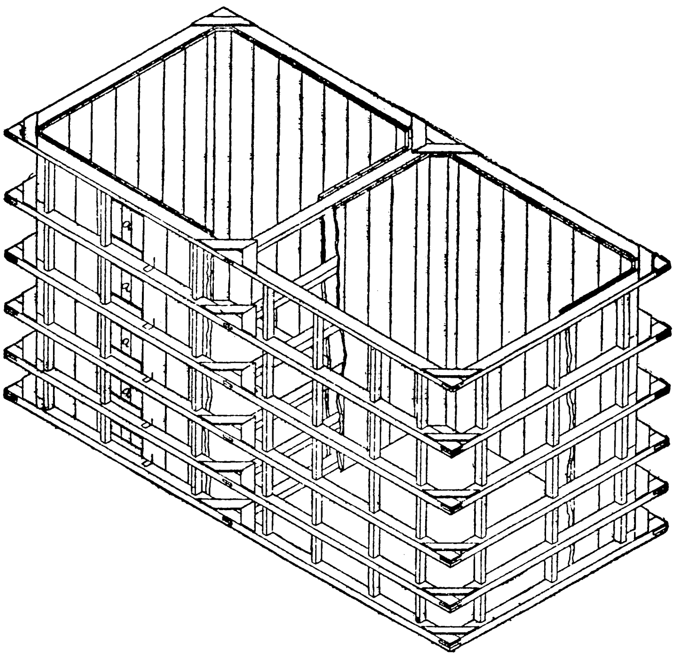

FIG. 8.—Construction of a double silo with horizontal girts.

In the above figure (fig. 8) *a a* represents the door, of which the five sections extend from sill to plate. Each pit is 18 feet square inside and 20 feet deep. Each outside girt is made of 3 planks, 2 by 10 inches, 20 feet long. The plate consists of two such planks. The girts of the cross wall are made of 2 by 8 planks. The girts are nearer together toward the bottom of the silo, where greater strength is required. The distances between these horizontal girts, measured from the upper surface of one to the lower surface of the next higher, beginning at the sill, are respectively 2 feet 6 inches, 3 feet, 3 feet 6 inches, 3 feet 9 inches, and 4 feet 5 inches.

Fig. 9 shows the details of the joint at the corner and at the intersection of cross wall and outer girt.

In this figure, *s s* are short supports of 2 by 6 plank between the different girts; *a*, a cross brace of 2 by 6 lumber, which, while strengthening

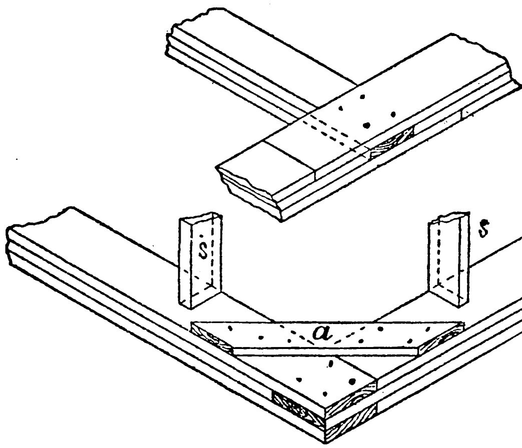

FIG. 9.—Construction of corner joint and cross-wall intersection.

the joints, dispenses with a right-angle inside corner. Two half-inch iron bolts are used in each joint, in addition to a number of twentypenny and fortypenny nails.

Fig. 10 shows details of the door. of which there is one section between each pair of girts.

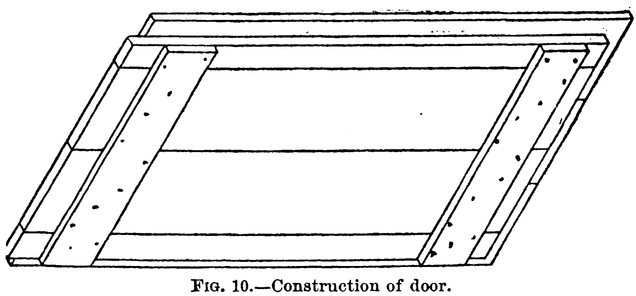

FIG. 10.—Construction of door.

Where one section of the door joins another or touches the silo lining, a lap joint is formed.

The following is the bill of materials for this double silo, omitting only the sheathing and battens, which serve as a protection against the weather:

	Feet.
105 pieces 2 by 10 inches by 20 feet, sills, girts, and plates	3,500
18 pieces 2 by 8 inches by 20 feet, sills, girts, and plates, cross wall.	540
35 pieces 2 by 6 inches by 18 feet, supports and cross corner braces.	630
300 pieces 1 by 12 inches by 20 feet lining planks	6,000
44 pieces 2 by 4 inches by 14 feet rafters	462
1 by 4 inch roof sheathing	800
	11,932

3,000 square feet tarred building paper, 10,000 shingles, 75 ½ by 7 inch iron bolts, 150 ½-inch washers, 1 keg fortypenny nails, 2 kegs twentypenny nails, 2 kegs tenpenny nails, 1 keg eightpenny nails, 30 pounds fourpenny nails.

Brick foundation wall 12 inches thick, 18 inches high: 4,500 bricks, 2 barrels lime, 2 barrels cement.

STAVE SILO.

The construction of a silo of this character at Ontario, Canada, which proved very successful, was as follows:

The diameter was 18 feet; the height was 20 feet. The silo was built of 2 by 6 inch pine plank, 20 feet long, dressed on one side, jointed and beveled to suit, and was set on a cedar plank bottom, cut round to a diameter of 18 feet 3 inches. The floor was laid on seven cedar sleepers, properly bedded and leveled. The silo was held together by means of seven ¾-inch round iron hoops. The only roof over this silo was a few poles on which pea straw was piled. The estimated cost is about $85. The principal objection to such a silo, and it is a serious one, is that the silage must be taken out over the top for each feeding, thereby involving much hard labor and inconvenience in handling.

COST OF SILO.

Numerous conditions affect the cost of building a silo. These are principally local, and involve cost of labor, lumber, stone or brick, size and style of structure, etc. As a first principle, the silo should be well made of good material. Temporary silos have been built in bays of barns, but these are not to be recommended as a rule. Good permanent silos should be made either within or without the barn, and be placed convenient for filling or feeding from. King has shown that there is a loss of less than 5 per cent of the dry matter of the silage in the center of the silo when properly made. In arguing for the proper construction of silos, he says:

If only such small losses of dry matter in the interior of the silo are necessary, the fact is an extremely important one to know. It is so because it emphasizes the great importance of building a thoroughly good silo whenever one is built at all. It shows that those who are advocating the building of cheap silos with open walls are doing the readers of agricultural literature a great injustice.

The good silo will save from 15 to 25 tons more silage in good condition out of every 100 tons than the poor silo can, and counting silage at the nominal price of $1 per ton we have an interest of $15 to $25 on $150 every year.

It is unquestionably true that the reason some people have condemned the silo and its contents is because they have built cheap, inferior silos in which good silage could not be preserved.

The round silo is preferable, for reasons already given, and, ton for ton capacity, it can be built at less expense than other forms. A round, steel silo, termed air-tight, was exhibited at the Columbian Exposition, but the cost of this is beyond the reach of the average farmer.

Numerous itemized estimates of the cost of silos have been published, mainly by the experiment stations. Below are given the cost of four

silos, of three forms. No. 1 is on the basis of estimates of the writer, to be within a barn and without roof and weatherboarding. The estimates on Nos. 2 and 3 are from figures given by King, while the figures for No. 4 are given by J. M. Turner, of Lansing, Mich. The cost given will, of course, vary some according to locality.

No. 1.—*Square silo, 100 tons, 15 by 15 feet inside, 26 feet deep.*

Cement, Portland, 3 barrels	$6.00	Tarred paper, 1,400 feet surface	$5.00
Foundation, 3 by 1½ feet by 66 feet	44.67	Gas tar, 1 barrel	3.00
Sills (136 feet linear measure) 2 by 12 inches by 18 feet	4.03	Nails	2.00
82 studs, pine, 2 by 12 inches	21.50	Bolts, hinges, and catches	3.95
Lining, No. 4 boards, 1,400 feet	16.50	Labor	15.00
Ceiling, 1,400 feet	28.00	Total	151.25
Top plate, 66 feet, 2 by 8 inches by 18 feet	1.60	Cost per ton, silo capacity	1.51

No. 2.—*Rectangular silo, 180 tons, 14 by 24 feet inside, 30 feet deep.*

Foundation, 13.44 perches, at $1.20	$16.13	Lining, surface fencing, at $15 per M	$63.84
Studding, 2 by 12 inches by 28 feet, 4,704 feet, at $20	94.08	Tarred paper, 426 pounds, at 2 cents	8.52
Sills, etc., 2 by 10 inches by 26 feet, 206 feet, at $19	4.94	Gas tar, 1 barrel	4.50
Sills, etc., 2 by 10 inches by 16 feet, at $14	5.96	Painting, 60 cents per square	15.00
Rafters, etc., 2 by 4 inches by 20 feet, 400 feet, at $16	6.40	Nails and hinges	10.00
Roof boards, fencing, 450 feet, at $15	6.75	Cementing bottom	5.00
Shingles, 5 M, at $3	15.00	18 ¾-inch bolts, 18 inches long	2.70
Drop siding, 8 inches, 2,779 feet, at $16	44.46	Carpenter labor at $3 per M and board	41.16
		Total	344.44
		Cost per ton, silo capacity	1.91

No. 3.—*Round silo, 180 tons, 20 feet inside, 30 feet deep.*

Foundation, 7.5 perches, at $1.20	$9.00	Tarred paper, 740 pounds, at 2 cents	$14.80
Studs, 2 by 4 inches by 14 and 16 feet, 1,491 feet, at $14	20.93	Gas tar, 1 barrel	4.50
Rafters, 2 by 4 inches by 12 feet, 208 feet, at $14	2.91	Hardware	6.00
Roof boards, fencing, 500 feet, at $15	7.50	Painting, 60 cents per square yard	13.20
Shingles, 6,000, at $3	18.00	Cementing bottom	5.00
Siding, rabbeted, 2,660 feet, at $23	61.18	Carpenter labor at $3 per M and board	33.17
Lining, fencing, ripped, 2,800 feet, at $18	50.40	Total	246.59
		Cost per ton, silo capacity	1.34

No. 4.—*Round silo, 208 tons, 23 feet inside diameter, 24 feet 10 inches deep.*

Excavation	$2.50	Sheathing: 2,700 feet ½ by 6 inches, 770 feet ⅞ inch	$55.00
Stone wall	43.00	Carpenter labor	72.00
Circle bonds, 2 by 8 inches, 80 linear feet	2.30	Hardware: Ten iron rods, ¼ inch diameter 3 feet 6 inches long, with nuts and washers; 36 ½-inch iron bolts 24 inches long, 3 bent at a right angle at one end for anchors	2.50
Circle plates, 2 by 4 inches, 490 feet	7.50	Total	298.98
Rafters, 56 pieces, 2 by 4 inches by 20 feet	6.25	Cost per ton, silo capacity	1.43
Siding, 2,280 feet, ⅝ inch	41.10		
Shingles, 6,000 C. B.	15.00		
2 dormer windows	20.00		
Studs, 170 pieces, 2 by 4 inches by 12 feet	16.68		
Nails	7.00		
Tarred paper, 408 yards (6½ rolls)	8.25		

SELECTION AND CULTURE OF SILAGE CROPS.

The plants most available for silage in the United States are Indian corn, red clover, rye, oats, wheat, sorghum, the millets, and alfalfa in the North, and soja beans and cowpeas in addition to the above in the South.

Indian corn is the great silage plant of America. It is adapted to a wide range of latitude and longitude, and will produce the largest amount of desirable silage per acre of any crop we can grow. Fifteen to twenty tons of green fodder can be grown on an acre without difficulty over a large part of the United States.

All the large varieties of corn are suitable for silage, but some are preferred to others. The important point is to secure as many tons of

food per acre as is possible. The larger dent varieties are the favorite ones for silage. Burrill and Whitman is one of the best known varieties, but for regions in the northern corn belt it does not mature soon enough to be entirely satisfactory. As a rule, the best corn for the silo, in any locality, is that variety which will be reasonably sure to mature before frost, and which produces a large amount of foliage and ears. Wisconsin Yellow Dent does well on the northern line of dent corn growing, while Burrill and Whitman, Leaming, and Dungan White Prolific will do well farther south. The common Southern Horse Tooth and Mosby Prolific are well adapted to the Southern States and are heavy yielders.

In preparing the soil, only the best of tillage and cultivation should be practiced. The soil should be fertile to yield an abundant crop of strong plants. The seed may be planted in drills 1 foot apart, in rows 3½ to 4 feet apart, according to locality. The cultivator may be started to advantage as soon as the young corn breaks through the surface, and the soil kept stirred and weeds destroyed, until cultivation is no longer practicable. It is a common practice now for some owners of silos to draw upon the general cornfield to fill the silo, not planting any special variety for this purpose.

Many experiments have shown that silage corn contains the most nutriment when the kernels begin to glaze, or when denting is well established, and before the lower leaves become dry. If cut before this period, too large a percentage of water is harvested in the crop, while the greatest development of food substance in the plant has not yet been reached.

Red clover has been stored green in the silo, but to a limited extent. This plant, if well preserved, makes the best of feed. There is no waste unless from decay. Horses, cows, and sheep relish it, and pound for pound clover contains more nutriment than corn or sorghum. The objections to storing clover in silos are—first, owing apparently to its rich composition, clover, unless well handled and stored, generates much heat, and often becomes injured in quality; second, corn will far outyield the clover in amount per acre. To make bright, sweet, aromatic clover silage, the crop must be cut when the plants are free from dew and when fairly well in bloom, and placed in a silo of good depth to insure its being well packed. Doubtless many valuable crops of clover could be saved from rain at harvest time by being put into the silo at the right time. It is not necessary to run clover through the fodder cutter before placing in the silo; but it is desirable, as it will pack better and can be handled more advantageously for feeding.

Sorghum has been used to some extent for silage, but as a rule it has not been entirely satisfactory when compared with corn. The plant lacks the nutritive quality of Indian corn, and the stalk is so hard that even when cut in short lengths it is not eaten with comfort by stock. Sorghum, however, will remain green later in the fall than corn, thus

extending the time for filling. Nevertheless, corn and clover are superior to sorghum for silage. A process to be recommended is the cutting of cowpeas or soja beans and placing them separately or together with the corn in the silo. This gives a more nutritious silage than corn alone. The average farmer would be more likely to preserve the peas or beans in a silo with corn than if placed in it alone. Canada field peas also make very nutritious silage.

There is no question but most green crops can be successfully ensiled; of these, taking all things into account, corn is decidedly the best.

FILLING THE SILO.

When corn is used, the entire plant, including the ear, should be placed in the silo.

The practice of cutting the crop by hand is general, although it may be done by horsepower. Harvesting machines of various patterns are made. Self-binders have been recommended, using them to cut one row of corn at a time. The most common form of harvester is a sled or drag of Λ form, with knives fastened to the edges or wings. This is drawn by one horse between two rows, the knives cutting the stalks near the ground. When not in use, the wings may be folded up over the center of the machine. One or two men ride on or walk beside the machine and gather the stalks into armfuls as cut, and place on the ground or on a wagon as convenient.

Numerous forms of wagons are used for carrying the crop from the field, but it is advisable, if possible, to use a low wagon, so as to save as much lifting as possible. Wagons of this character are sold in the market, or one can have special small wheels, with tires 4 or 6 inches wide, made for putting on a common farm wagon.

At one time it was considered advisable to allow the corn to wilt in the field before putting in the silo, it being thought to keep better. This practice is no longer considered important, and many silos are now filled most successfully as fast as the crop can be drawn from the field and cut.

Rapidity of filling is unimportant, so long as fresh fodder is placed in the silo before mold is formed at the surface.

Corn may be placed in the silo uncut, but this practice is objectionable. The stalks will not pack as closely as the cut fodder, and it is not so convenient to handle or economical for feeding purposes. The fodder cutter should be placed so as to deliver the cut material as near the center of the silo as possible, so that it may be distributed evenly all over the pit. Carriers of different lengths may be purchased of most firms manufacturing fodder cutters, so that the material can be placed where wanted. The shorter the fodder is cut the more satisfactory it is for feeding. One-half inch is a very common length.

It is desirable to have a careful person inside the silo to distribute the fodder and trample well at the corners and along the sides, thus

having the contents evenly and thoroughly packed during filling. The silo should be filled above the top edge, as the silage will settle considerably below it during the process of fermentation or heating. Temporary boards may be placed above the edge for a few days, or fresh silage may be added to fill up the settled space, provided the contents have not molded at the surface.

When the process of ensiling was first introduced in America it was customary to place a close layer of boards on the surface of the silage, over which was placed a heavy weight. The idea was to press the silage as heavily as possible and exclude the air. The weighting process was found to be unnecessary, however, and this has been generally dispensed with. After filling, some persons begin feeding out from the top at once, thus preventing all waste at that point. Others place cut chaff or straw on the silage to a depth, when settled, of 6 inches to 1 foot. This prevents the decay of the silage. Perhaps the most satisfactory method is to place a layer of tarred paper smoothly over the surface of the silage and then cover this to a depth of a foot or so with cut straw.

When the corn is cut in a very dry season and is not ordinarily juicy, it will be advisable to pour considerable water on the silage after the silo is filled, especially when the contents are at a high temperature.

COST OF SILAGE.

There is much difference of opinion on the cost of producing a ton of silage. Local conditions of labor, real estate values, fertility of soil, facilities for handling crop, etc., are important factors in this matter. In 1892 the writer asked the owners of thirty-five silos in Indiana, "How much does your silage cost you per ton?" The lowest estimate was 25 cents and the highest about $4. In both of these cases we have extremes. Taking all factors into account, the writer estimates the cost at $1.50 per ton at Lafayette, Ind. No doubt in many places the cost can be materially reduced below this sum.

COMPOSITION AND FEEDING VALUE OF SILAGE.

Many analyses have been made of silage by chemists. The following table gives the average composition of different kinds of silage as compiled from American analyses:

Composition of different kinds of silage.

Material.	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Corn silage	79.1	1.4	1.7	6	11	0.8
Sorghum silage	76.1	1.1	.8	6.4	15.3	.3
Red clover silage	72	2.6	4.2	8.4	11.6	1.2
Soja bean silage	74.2	2.8	4.1	9.7	6.9	2.2
Cowpea vine silage	79.3	2.9	2.7	6	7.6	1.5
Field pea vine silage	50.1	3.5	5.9	13	26	1.6
Silage of mixture of cowpea and soja bean vines	69.8	4.5	3.8	9.5	11.1	1.3

In making silage it is important to have as much dry matter in it as possible without injuring the character of the feed. Some years ago it was the practice to cut the corn plant when somewhat less mature than is now considered the proper state for silage, so that it probably contained more water than average silage now does.

Analyses at the Indiana Station have shown silage to contain as low as 67.69 per cent water in the center of the silo, while at both the Minnesota and Wisconsin stations silage has been fed containing only 71 per cent water. King has shown in interesting tests that there is a difference in dry matter of only 2.34 per cent between the fresh sample of corn fodder and the silage made from it, there being 31.14 per cent in the fresh sample and 28.80 per cent in the silage. For this reason it is preferable to allow the corn plant to develop as fully as possible in the field without permitting the leaves to turn brown and dry.

If we compare the chemical composition of corn silage with green corn fodder, and red clover silage with green clover, we will notice that they differ but slightly in composition, that the loss of protein in ensiling is very slight, and that there is a gain in fiber and fat.

Composition of corn and clover before and after ensiling.

Material.	Water.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Corn fodder (green)	79.3	1.8	5	12.2	0.5
Corn silage	79.1	1.7	6	11	.8
Red clover (green)	70.8	4.4	8.1	13.5	1.1
Clover silage	72	4.2	8.4	11.6	1.2

The difference in the composition of the two fodders of either class is insignificant in those ingredients upon which the value of a food mostly depends.

The economy in using a feeding stuff depends mainly upon its cost of production, palatability, digestibility, and influence on animal production. How much of the several components of different foods is digestible in equal amounts is a most important consideration. Allen gives the following as the number of pounds of digestible food ingredients in 100 pounds of green corn, corn fodder, and corn silage:

Digestible matter in 100 pounds of corn fodder and corn silage.

	Dry matter.	Protein.	Carbohydrates.	Fat.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Corn fodder (green)	20.7	1.10	12.08	0.37
Corn silage	20.9	.56	11.79	.65
Corn fodder (dry)	57.8	2.48	33.38	1.15

Placed on a more practical basis, using figures obtained in digestion experiments conducted by Armsby at the Pennsylvania Station, the

following yields of digestible material are given for 1 acre of land, from which the same variety of corn was taken:

Digestible matter in corn from one acre.

Ingredients.	Green fodder.	Silage.	Field-cured fodder.
	Pounds.	*Pounds.*	*Pounds.*
Albuminoids	184	82	133
Nonalbuminoids	67	151	69
Carbohydrates	3, 947	3, 164	3, 030
Fat	153	263	156
Total digestible substance	4, 351	3, 660	3, 388

From this table it is seen that more digestible food per acre is secured from green fodder than from silage, and in turn from silage than from field-cured fodder. The chief deficiency of the silage occurs in the albuminoids, which are the most valuable food ingredients.

Numerous experiments have been conducted to show the relative digestibility of the corn plant dry or as silage. The difference in feeding value as based on these tests is small, though as a rule it slightly favors silage, it being more digestible than the dry fodder.

Patterson says, after comparing the results of feeding rations of silage and corn fodder:

We see there is but little difference between the digestibility of the silage and the fodder rations, the slight difference which occurs being in favor of the silage. But we must not overlook or forget the fact that this slight difference is in all probability due to the difference in methods of growing the fodder and not to any extent to be attributed to the ensiling. Corn stover (fodder) has been found to differ but slightly in digestibility from corn fodder or corn silage. The digestibility of the crude protein is very nearly the same in each, that of the silage being slightly the higher. The fat in the silage is also more digestible, but this may be due almost entirely to the amount of acid which the silage contains.

FEEDING SILAGE TO FARM STOCK.

The first general use of silage as a stock food was with dairy cattle. The extensive erection of silos in many parts of the country, however, has resulted in its adoption in the feeding ration by many breeders of horses, beef cattle, and sheep.

DAIRY CATTLE.

At the Wisconsin Station a daily ration of 4 pounds of hay and 7 pounds of grain with corn silage or field-cured corn fodder was fed to 20 cows for 16 weeks. During the silage feeding 19,813 pounds of milk were produced, and 19,801 pounds during the corn-fodder feeding. Taking into account the areas of land from which the fodder and silage corn were produced, it is shown that the silage would have produced 243 pounds more milk per acre than the dry fodder, or the equivalent of 12 pounds of butter, a gain of slightly over 3 per cent in favor of the silage.

At the Vermont Station silage gave favorable results with dairy cattle. The yield of milk was larger from silage than from corn fodder, but of slightly poorer quality, containing on an average 12.91 per cent solids and 4.05 per cent fat, while that from cows fed corn fodder contained 13.25 per cent solids and 4.28 per cent fat. The total yield of the milk constituents was higher with silage feed. Considering the yield of milk and butter fat from the two above feeds, grown on equal areas of land, the result was favorable to silage at the rate of 8 per cent more milk, 5 per cent more solids, and 3 per cent more fat. One pound of dry matter in silage produced more milk and slightly more solids and fat in 6 out of 9 cases than 1 pound of dry matter in corn fodder.

At the Ohio Experiment Station, for four years in succession, comparisons were made of the relative influence of silage and beets in milk production. In comparing the results in pounds of milk produced for 100 pounds of dry matter consumed, it appears that in the general average of all experiments 100 pounds of dry matter had produced about 4 pounds, or, approximately, 6 per cent more milk when the cows were fed on silage than on beets.

The Pennsylvania Station in experiments along the same line secured results of much the same character as those of Ohio. It required from 0.20 to 0.33 pound more digestible matter to produce 1 pound of butter fat during the time when roots were fed than when silage was fed.

In experiments on milch cows at the Massachusetts Experiment Station, silage, consisting of a mixture of corn and soja beans, proved itself to be fully equal if not superior to hay in producing milk, without affecting the quality, and at the same time decreasing the absolute cost. In other experiments at the Massachusetts Station comparisons were made of the influence of corn fodder, corn stover, corn silage, and English hay on milk production. The foods were fed with grain. As bearing on the cost of milk production, in every instance the cost was greatest where hay was fed. Whenever a part of the hay was replaced by either corn fodder, stover, or silage the cost was materially reduced. When the corn fodder, stover, or silage was fed alone, the cost was likewise reduced, and at the prices charged little uniform advantage in favor of either food could be traced. In experiments extending over 5 years corn silage was fed most advantageously in place of one-fourth to one-half of the full hay ration. From 35 to 40 pounds of silage per day, with all the hay called for to satisfy the animal, in addition to the grain ration, seemed a good proportion.

At the Missouri Station Sanborn, who has from the first placed a higher value on dry fodder than silage, found dry fodder more effective food for cows than silage, especially when sweet-corn fodder was used. On this cows gave better butter and richer milk.

The popularity of the silo with owners of dairy cattle has increased very greatly. Few owners of stock of this class, who have properly built silos and well preserved silage, would discard silage as an adjunct to feed-

ing. Silage certainly promotes milk flow. One great argument in favor of its use lies in the cheapness of production per ton and the ability to store and secure a palatable, nutritious food in weather conditions that would seriously injure hay or dry fodder.

Georgeson, of the Kansas Station, says:

If we estimate that 77.2 per cent of the amount put in can be taken out sound and available for feeding, or 1,544 pounds for every ton put in the silo, we find that at the average feed of 32 pounds per day 1 ton will last 1 animal 48.2 days, or 100 tons will last a herd of 25 head 192 days; and in a reasonably favorable season, with good care and good culture, this 100 tons may be grown on about 10 acres. What other method of handling corn fodder will maintain an average farm herd during the long winter season, from grass until grass comes again, on so small an area?

There is one point that it is important that owners of milk cattle should bear in mind, and that is when the silo is first opened only a small feed should be given. In changing from grass or dry feed to silage, if a regular full ration is given, the silage will perhaps slightly affect the taste of the milk for a few milkings, and if the change is from dry feed it may cause too great activity of the bowels.

BEEF CATTLE.

Silage has not been fed so extensively to beef cattle as to the dairy class, but as a rule its feeding has been attended with success. Voelcker, at Woburn, England, fed 12 Hereford steers, one-half of them hay and grain and the other half grass, silage, and grain. The experiment extended over 80 days. At the beginning of this test the silage-fed animals weighed 2 pounds more than the hay-fed ones; at the end the former had gained 512 pounds and the latter 418 pounds—a gain per head daily for the silage-fed of 1.6 pounds and 1.3 pounds for the hay-fed. It was estimated that it cost 4 cents more per pound of increase of dead weight produced on hay than it did for that produced on silage.

At the Indiana Station the writer fed 8 steers 42 days. Four steers were given silage and grain and 4 clover hay and grain. The general health of each lot was good. Each steer fed silage gained on an average 1.75 pounds per day, while the clover-fed animals gained 1.4 pounds per day. At the end of the 42 days' feeding the silage-fed steers had gained a profit of $19.20, and the clover-fed of $16.76, or $2.50 in favor of the silage lot.

At the Wisconsin Station 4 steers were fed silage without grain and 4 silage with shelled corn and bran. The lot getting silage gained 222 pounds, while those fed grain in addition gained 535 pounds, or a gain of 1.5 pounds each per day, for the first lot, and 3.7 pounds per day where grain was fed.

At the Maine Station it was found that a pound of digestible matter from corn silage produced more growth than a pound of digestible matter from timothy hay, but the difference was small.

In experiments at the Missouri Station the amount of dry matter eaten per pound of increase in weight was 13.72 pounds on the silage

ration and 15.79 pounds on corn fodder, slightly favoring the silage. On the basis of gain per pound of dry matter harvested, however, the advantage was claimed to be in favor of the corn fodder. The Utah Station also reports unfavorably on the use of silage in feeding steers as compared with corn fodder.

At the Texas Station dry corn fodder did not give as large gain as silage when each was fed with cotton-seed products. While 53 per cent of the corn fodder was rejected by the animals, only 8.2 per cent of the silage was refused.

At the Agricultural College at Guelph, Ontario, Canada, silage was compared with roots on 6 steers. The conclusion was reached that corn silage and meal will fatten as effectively and cheaply as a ration of roots, hay, and meal, and with less expenditure of labor.

In an experiment reported by H. E. Alvord, 90 3-year-old steers were divided into 3 lots as evenly as possible. Lot 1 was fed 20 pounds of hay and 3 pounds of grain daily, each, and allowed to run in a yard with sheds for shelter. Lot 2 was kept in a warm stable and fed 17½ pounds of hay, 15 pounds of mangel-wurzels, and 3 pounds of grain. Lot 3 was fed 85 pounds of silage and 3 pounds of grain, and confined in stanchions. Lot 3 gained one-fourth of a pound per day a head more than lot 2 and one-half pound more than lot 1. The cost of food was 5 per cent in favor of lot 3.

Silage has come to be highly esteemed as an addition to feeding rations for animals intended for the show ring.

HORSES.

It is not the general practice to feed silage to horses, but in numerous cases it has been fed to them with success.

When silage was first introduced, numerous instances occurred of injury resulting from feeding it to horses. This was probably due to giving too large an amount for the small stomach of the horse. This caused colic or some similar trouble. The writer knows of several cases where horses have died when fed silage, but it could not be demonstrated that the silage was at fault, though suspicion pointed that way. This food when very acid should be fed to horses only in a limited way. In discussing this question, Stewart notes that there have been many fatal cases of stable horses eating too much grass. Evidence is quite as strong that grass has caused fatal results as often as silage. The change from dry feed to grass or silage must be very gradual. Stewart fed silage to four horses for two winters, adopting the same precautions as he would in feeding grass, the results being quite satisfactory.

Alvord states that mules have been kept almost exclusively on silage, and notes a case of a large farmer and grape grower in North Carolina who has for several years made silage of cowpeas and used it as the chief forage for a number of mules kept constantly at work. In this case it was found an economical and desirable food.

The Royal Commission, which made an investigation of the merits of silage in England, reported:

Strong as the evidence has been of the advantage of silage for keeping stock in healthy condition, the farm horses have by no means been excepted. We have received highly satisfactory accounts from several quarters of the health of working teams when given a limited proportion of silage mixed with other food.

At the agricultural experiment stations but few feeding experiments of any kind have been attempted with horses, and in this work silage has played but a small part. At the Ohio Station about 20 pounds of silage per day was fed to horses instead of hay during February and March. The result appeared beneficial as indicated by increase of appetite and improvement in the spring coat of hair.

Among the most important evidence unfavorable to the use of this food for horses is that from M. W. Dunham, of Wayne, Ill., a large horse breeder and importer. In a letter to the writer, dated May 17, 1895, he says:

I put up silage two years for feed for my horses, but the results were so unsatisfactory that I discontinued its use. I don't consider it fit feed for them.

Coming from the source it does, such testimony has more than ordinary value.

Although considerable testimony is at hand showing that silage has been fed to horses with success, the indications are that its use can be recommended only when fed to a limited extent in connection with hay, straw, or corn fodder.

SHEEP.

Sheep have been fed silage with much caution from its first introduction, but the use of this food with sheep feeders is becoming more extensive. Old sheep, yearlings, and lambs may be much improved in condition if fed good silage.

At the Utah Station one lot of 3 sheep were fed silage, and another lot of 3 dry corn fodder, with results favorable to the use of the fodder.

At the Massachusetts Station 6 sheep were fed during one period a ration of gluten feed, cotton-seed meal, and second-crop hay (rowen). After feeding this ration, corn and soja bean silage was substituted for the hay and fed 7 weeks. The difference in gain in weight in one period over the other was very slight, being 2.5 pounds in favor of the hay for the 2 sheep for 7 weeks. The silage ration, however, cost $5.58 as compared with the $6.26 for the hay, and it cost more to make a pound of gain with the hay than with the silage.

At the Wisconsin Station wether lambs were fed several different rations. Silage from both corn and clover was fed in special cases.

The corn and the clover silage proved to be good additions to the rations. They apparently had the effect of keeping the digestive organs of the wethers in healthy condition. The corn silage, considering its conduct as a food, and the fact that it can be preserved cheaper and better than the clover silage, was the most satisfactory.

In another experiment it was found that—

Of the succulent fodders, the best results were obtained from feeding corn silage. It is cheap, the ewes like it, and they can easily be kept in a healthy condition when it forms part of the ration. The only danger lies in the fact that it may contain too much corn for breeding ewes. Next to it comes sugar beets, and lastly the clover silage, which was not eaten as eagerly as either of the other fodders, and the amount of refuse was greater and the cost higher.

Extensive experiments in feeding lambs were carried on in 1892–93 at the Michigan Station. One hundred and twenty-five sheep were divided into 10 lots, each lot being as uniform as possible, and 10 different rations were fed. Lot 9, that received silage, ranked third in the economy of the cost to produce 1 pound of gain. In comparing one lot fed roots with another fed silage, each lot made the same gain, but the profit on those fed roots was 22 cents on each lamb, while those fed silage gave a profit of 63 cents. This result corroborated previous experience at this station.

At Cornell University 2 lots of ewes in milk were fed for 2 years in succession, one lot receiving mangel-wurzels, the other corn silage with the grain in it. In addition to the above foods one lot was fed a mixture of 2 parts of bran, 1 part of corn meal, and 1 part of cotton-seed meal. The roots and silage were fed once a day and the ewes were given all they would readily eat. The ewes ate the silage in a satisfactory manner, and ate a little more grain than did the sheep eating beets, though hardly enough more to denote a greater appetite due to silage. The early lambs suckling silage-fed ewes, for both years, averaged a gain of 3.49 pounds a week, while those suckling root-fed ewes gained 3.33 pounds per week.

E. K. Seabury, of New Hampshire, states that he is very positive that no one need hesitate a moment in feeding silage to sheep, and that he can furnish abundant testimony from good practical men that it is as good for sheep as for cattle.

He also reports that certain prominent breeders of Merino sheep in Vermont have fed their sheep largely on silage with highly satisfactory results.

There seems to be but little testimony unfavorable to the use of silage for sheep, and there is no reason why this fodder should not be fed to a reasonable extent instead of roots. The feed, however, should not be exclusively silage, but this should be fed as an addition to grain.

SWINE.

Numerous attempts have been made to feed swine silage, but without success. In some cases swine have gained something probably from the grain that might be present in the silage, but no available data seem to demonstrate satisfactory results from such feeding. The Utah Station reports, as a result of experiments, that silage is unfit for pigs and that they do not like it. At the New York State Station feeding

experiments in this line have proved entirely unsatisfactory. Henry reports that he has repeatedly tried corn and clover silage as a food for swine, but without success.

CONCLUSIONS.

From a practical standpoint, the value of silage as a food may be shown in several ways. It is as easily digested as the same plant preserved dry. It keeps the digestive system in a state of healthy activity, thereby aiding digestion. It is generally considered that horses and cattle fed silage show the beneficial effects of this food in the more healthy condition of the skin, as evidenced in its pliable, mellow condition, and the softness and luster of the coat of hair. Animals usually eat sound silage with a relish, and reject it only when decay is present. For milch cattle it seems especially well adapted, and the silo has proved an important and economical addition to the dairy farm.

The effects on the milk and butter through feeding silage to dairy cattle was inquired into by the Royal Commission appointed in England. The findings of this commission were as follows:

	Effect on—	
	Milk.	Butter.
No change	22	1
Improved in quantity and quality	95	18
Decreased in quantity and deteriorated in quality	1	....
Increased quantity	93	13
Decreased quantity	5	2
Improved quality	34	26
Deteriorated quality	5	3
Improved quality and decreased quantity	4	....
Increased quantity and deteriorated quality	5	....
Favorable results (whether in quantity or quality not stated)	30	15
Unfavorable results	....	1

This important testimony generally favors the use of silage for dairy cattle.

Though not extensively used for the purpose, silage forms a valuable addition to the rations of sheep, and serves as a good and cheap substitute for roots. Its use as food for swine has not been successful.

Silage provides succulent food for farm animals at a time of year when vegetation is dead, and so in a large degree replaces pasturage.

It is not desirable or advisable to depend on silage alone for rough food. It should be fed only in a limited way in connection with hay and grain. For matured cattle, 25 to 35 pounds per day is a reasonable allowance. Horses should have less, and sheep only 2 or 3 pounds each.

Of the green fodders suited to silage, Indian corn, all things considered, is best and cheapest.

The proper time to harvest any green crop for silage is at maturity, before the leaves turn brown and when the water content of the plant begins to diminish.

Generally speaking, 3 tons of silage are equal in feeding value to 1 ton of hay. On this basis a much larger amount of digestible food can be secured from an acre of silage corn than from an acre of hay. The food equivalent of 4 tons of hay per acre can easily be produced on an acre of land planted to corn.

The silo provides a more economical and compact method of storing fodder than the hay mow. A silo of 180 tons capacity which will con tain 54 tons of dry matter will hold less than 23 tons of red clover hay containing less than 20 tons of dry matter. The advantage of storage capacity clearly rests with the silo.

The silo is especially adapted to intensive farming, where land is high in value and storage space is limited.

A carelessly constructed silo is an extravagance. A well-made one is an economy. Temporary structures are not advisable.

FARMERS' BULLETINS.

These bulletins are sent free of charge to any address upon application to the Secretary of Agriculture, Washington, D. C. Only the following are available for distribution:

No. 15. Some Destructive Potato Diseases: What They Are and How to Prevent Them. Pp. 8.
No. 16. Leguminous Plants for Green Manuring and for Feeding. Pp. 24.
No. 18. Forage Plants for the South. Pp. 30.
No. 19. Important Insecticides: Directions for Their Preparation and Use. Pp. 20.
No. 21. Barnyard Manure. Pp. 32.
No. 22. Feeding Farm Animals. Pp. 32.
No. 23. Foods: Nutritive Value and Cost. Pp. 32.
No. 24. Hog Cholera and Swine Plague. Pp. 16.
No. 25. Peanuts: Culture and Uses. Pp. 24.
No. 26. Sweet Potatoes: Culture and Uses. Pp. 30.
No. 27. Flax for Seed and Fiber. Pp. 16.
No. 28. Weeds; and How to Kill Them. Pp. 30.
No. 29. Souring of Milk, and Other Changes in Milk Products. Pp. 23.
No. 30. Grape Diseases on the Pacific Coast. Pp. 16.
No. 31. Alfalfa, or Lucern. Pp. 23.
No. 32. Silos and Silage. Pp. 31.
No. 33. Peach Growing for Market. Pp. 24.
No. 34. Meats: Composition and Cooking. Pp. 29.
No. 35. Potato Culture. Pp. 23.
No. 36. Cotton Seed and Its Products. Pp. 16.
No. 37. Kafir Corn: Characteristics, Culture, and Uses. Pp. 12.
No. 38. Spraying for Fruit Diseases. Pp. 12.
No. 39. Onion Culture. Pp. 31.
No. 40. Farm Drainage. Pp. 24.
No. 41. Fowls: Care and Feeding. Pp. 24.
No. 42. Facts About Milk. Pp. 29.
No. 43. Sewage Disposal on the Farm. Pp. 22.
No. 44. Commercial Fertilizers. Pp. 24.
No. 45. Some Insects Injurious to Stored Grain. Pp. 32.
No. 46. Irrigation in Humid Climates. Pp. 27.
No. 47. Insects Affecting the Cotton Plant. Pp. 32.
No. 48. The Manuring of Cotton. Pp. 16.
No. 49. Sheep Feeding. Pp. 24.
No. 50. Sorghum as a Forage Crop. Pp. 24.
No. 51. Standard Varieties of Chickens. Pp. 48.
No. 52. The Sugar Beet. Pp. 48.
No. 53. How to Grow Mushrooms. Pp. 20.
No. 54. Some Common Birds in Their Relation to Agriculture. Pp. 40.
No. 55. The Dairy Herd: Its Formation and Management. Pp. 24.
No. 56. Experiment Station Work—I. Pp. 30.
No. 57. Butter Making on the Farm. Pp. 15.
No. 58. The Soy Bean as a Forage Crop. Pp. 24.
No. 59. Bee Keeping. Pp. 32.
No. 60. Methods of Curing Tobacco. Pp. 16.
No. 61. Asparagus Culture. Pp. 40.
No. 62. Marketing Farm Produce. Pp. 28.
No. 63. Care of Milk on the Farm. Pp. 40.
No. 64. Ducks and Geese. Pp. 48.
No. 65. Experiment Station Work—II. Pp. 32.
No. 66. Meadows and Pastures. Pp. 24.
No. 67. Forestry for Farmers. Pp. 48.
No. 68. The Black Rot of the Cabbage. Pp. 22.
No. 69. Experiment Station Work—III. Pp. 32.
No. 70. The Principal Insect Enemies of the Grape. Pp. 24.
No. 71. Some Essentials of Beef Production. Pp. 24.
No. 72. Cattle Ranges of the Southwest. Pp. 32.
No. 73. Experiment Station Work—IV. Pp. 32.
No. 74. Milk as Food. Pp. 39.
No. 75. The Grain Smuts. Pp. 20.
No. 76. Tomato Growing. Pp. 30.
No. 77. The Liming of Soils. Pp. 19.
No. 78. Experiment Station Work—V. Pp. 32.
No. 79. Experiment Station Work—VI. Pp. 28.
No. 80. The Peach Twig-borer—an Important Enemy of Stone Fruits. Pp. 16.
No. 81. Corn Culture in the South. Pp. 24.
No. 82. The Culture of Tobacco. Pp. 23.
No. 83. Tobacco Soils. Pp. 23.
No. 84. Experiment Station Work—VII. Pp. 32.
No. 85. Fish as Food. Pp. 30.
No. 86. Thirty Poisonous Plants. Pp. 32.
No. 87. Experiment Station Work—VIII. (In press.)
No. 88. Alkali Lands. (In press.)
No. 89. Cowpeas. (In press.)